

CarSim Problems Brake System Design

You are working on the design for the brake system on a new passenger car. The car must meet the following braking performance requirements both lightly loaded and at gross vehicle weight (GVW):

Dry pavement ($\mu = 0.85$) Stopping distance ≤ 56 m from 100 km/h (0.7 g's)

Wet pavement ($\mu = 0.3$) Stopping distance ≤ 40 m from 50 km/h (0.25 g's)

The relevant specifications of the vehicle are:

Wheelbase	2.69 m	
Tire radius	301 mm	
Brake gains (per wheel)	330 N-m/mPa (front)	200 N-m/mPa (rear)
	Lightly-loaded	GVW
CG Height (total vehicle)	516.6 mm	539.2 mm
Front Axle Weight	1051.4 Kg	1120 Kg
Rear Axle Weight	655.6 Kg	1120 Kg

You are to select a pressure proportioning system (break pressure and rise rate - see page 66) and then determine the efficiency of the system for the lightly-loaded and GVW conditions. Do this via the following steps:

a) Calculate and plot the four performance triangles on the front/rear brake force diagram (as in Fig 3.9 of the text) for all conditions.

b) Select the parameters for a proportioning valve (pressure break point and slope) to be used and show it on the diagram.

c) Calculate and plot the braking efficiency for the lightly-loaded and fully loaded vehicle as a function of application pressure for the design you selected. Show your calculations in a table similar to that shown on Page 76 of the textbook. (*This would be an excellent occasion to use a spreadsheet.*)

d) Set up a CarSim test to check out the design of your brake system. Vary the brake application to see how much deceleration you can obtain in each of the four conditions without wheel lockup. Enter the values in a table as follows:

	High μ	Low μ
Lightly Loaded	_____ (g's)	_____ (g's)
GVW	_____ (g's)	_____ (g's)

Print out a copy of your plot screens for each of the four conditions.

CarSim Exercise #3

CarSim #3a – Brake tests @ Lightly-loaded

Objective: To verify the stopping distance for the lightly loaded car.

1) Start CarSim and on the Run Control screen select the data set *Brakes: Sedan, Big, FWD: Split Mu*. Click New and give it the name *HW3: LL*. Type your name into the Category data field for this and all other new screens you make.

2) Go to the Vehicle Assembly screen, click New and name it *HW3Sedan: LL*.

3) Go to the Vehicle: Sprung Mass screen, click New and name it *HW3SM: LL*. Set the height of each of the wheels to 301 (four places).

4) From the Vehicle Assembly screen go to the Brake System: 4-wheel system. Click new and rename it *HW3Brakes*.

5) Go to the Rear Prop/limit valve, click New, name it, and put in the proportioning valve parameters (break point pressure and slope) you chose for your design. It is set up to provide pressure proportioning that is also load sensitive. We will not be using the load sensitive portion, so all you will have to do is change line 3 to your proportioning break point. I.e., enter your break point pressure value three times, separate by commas. Then on the next line enter a high value of front application pressure (near the top of your graph), and then enter the corresponding rear application pressure twice, separated by commas.

6) Go back to your Brakes: Four-wheel System and choose the pressure proportioning you just made up. Continue working your way up to the Run Control screen, making sure you have linked to each change you have made.

7) On the Run Control screen you need to make several more changes. Be sure to select your *HW3Sedan: LL* as the vehicle. Under Environment: 3D Road, select Straight: Flat, which has a friction coefficient of 0.85 (Check to make sure). Under controls set the speed to 100 km/h. Click on the Braking link and make up your own table as follows:

0.0, 0.0

1.0, 0.0

1.1, P* (Where P* is some application pressure you want to set).

10, P*

Look at your calculations to estimate what value of P* you can use to for each of the conditions you are testing.

8) Choose the plots to show V_x – wheel speeds (all), P_{bkCh} – chamber pressure (all) and A_x – long. accel. Of CGs.

9) Run the simulation to conduct a braking test to see if your brake system can achieve a deceleration of at least 0.7 g required by the regulations. Vary the brake application pressure to see how much deceleration can be achieved without wheel lockup. Once satisfied that you have met the requirements, print out the Plot screen.

10) On the Run control screen, click the Road link and make up a new road with a 0.3 coefficient of friction. Select this road on the Run control screen and test your brake system on it for the lightly loaded case. Again, print out the Plot screen when you have verified your design.

CarSim #3b — Brake tests @ GVW

Objective: To verify the stopping distance for the fully loaded car.

1) Go to the Vehicle Assembly screen. Click new and label it *HW3Sedan: GVW*. Change the mass value to 2060 kg, its longitudinal position to 1358 mm, and the sprung mass CG height to 560 mm.

2) Work your way back to the Run control screen making links wherever needed. Run the car at GVW on the high μ and low μ surfaces to see how much deceleration you can achieve. Note: the calculations you did in Part c of the homework problem should help you quickly find the right application pressure value to achieve best stopping performance without wheel lockup.